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# בקשה לפטנט
Application for Patent

אני, (שם המבקש, מענו ולגבי גוף מאוגד - מקום התאגדותו)
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(בעברית) (Hebrew)

התקן לאיחוי שברי צוואר הירך

(באנגלית) (English)

**OSTEOSYNTHESIS DEVICE FOR HOLDING TOGETHER IN COMPRESSION THE PARTS OF A FRACTURED FEMUR NECK**

hereby apply for a patent to be granted to me in respect thereof.
מבקש בזאת כי ינתן לי עליה פטנט

| • בקשת חלוקה — Application of Division | • בקשת פטנט מוסף — Application for Patent Addition | • דרישה דין קדימה Priority Claim | | |
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התקן לאיחוי שברי צוואר הירך

# OSTEOSYNTHESIS DEVICE FOR HOLDING TOGETHER IN COMPRESSION THE PARTS OF A FRACTURED FEMUR NECK


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# OSTEOSYNTHESIS DEVICE FOR HOLDING TOGETHER IN COMPRESSION THE PARTS OF A FRACTURED FEMUR NECK

## FIELD AND BACKGROUND OF THE INVENTION

The invention relates to medicine and in particular to devices applied for osteosynthesis at femur neck fractures.

The FIG.1 drawing illustrates terms used here to define the location of femur parts and kinds of femur neck fractures. This drawing shows femur **11** (Hip bone), femur head **12** (Capest), femur neck **13** (Collum), characteristic femur areas- Trochanter major **14**, Trochanter minor **15**, Undertrochanter area **16**, so-called Cortical layer **17** and Diafiz **18**.

Femur neck fractures (FIG.1) are divided into medial fractures and lateral fractures. Medial fractures include subcapital fracture **21**, transcervical fracture **23** and basal fracture **25**. Lateral fractures include transtrochanter fracture **27** and intertrochanter fracture **29**.

The problem of treating femur neck fractures is of great social importance, especially in geriatrics. This kind of injuries is most frequent with elderly people. The number of such injuries essentially increases towards the age of 70 and is often caused by a relatively light trauma, non-coordinated movements, sharp turns, walking, going upstairs, lifting and carrying heavy loads, as due to senile osteoporosis characteristic of elderly people the bones become more brittle and fragile. Unfortunately femur neck fractures, especially subcapital fractures, knit badly, so that for elderly people they often become a fatal disaster.

Only in USA medical statistics estimates 250 thousand femur neck fractures annually. 20% of victims die within a year. After a year' treatment 15-20% of patients are still in need of care, with 50% of them aftereffects are found. $ 7 billions are annually spent in USA to provide medical care of patients with femur neck fractures (H.W. Wahner, 1987).

The vast majority of elderly people with femur neck fractures have age changes of different prominence and suffer from internals diseases. They have limited reserve and protective forces of the organism. Even after correct and timely osteosynthesis with elderly and old people nonunion of femur neck fractures and development of femur head necrosis occurs nearly in 30 % of patients (A.V.Kaplan, 1979).

Most of patients in this age group suffer from pronounced osteoporosis. Therefore stops are badly fixed in a porous bone. This often results in a second displacement and nonunion of bone fragments. In this age subcapital femur neck fractures occur most frequently, and fragments fixing at osteoporosis appears to be inadequately stable. Therefore recently at femur neck fractures with elderly people endoprosthesis is performed. Total replacement of the thigh joint in such patients is carried out very seldom because of its traumatability, hemophilia as well as of osteoporosis and essential operational risk. Endoprosthesis at femur neck fractures is performed more often though there is a great number of contraindications to its application. It would not be correct to apply it at all femur neck fractures in elderly patients.

Closed osteosynthesis by means of a special device to treat such fractures would be the best way for elderly people. Even in case of its

unfavorable outcome in distant future it may provide sufficient existence of the patient in the immediate future.

Numerous devices have been developed world over for closed osteosynthesis at femur neck fractures, such as Compression Richard screw system by "Richards Manufacturing Co. Inc.", Memphis, Tennessy, USA, see U.S. Pat. No. 4,095,591.

The compression screw system includes an extension is provided for being nonrotatably fixed to a lag screw that is to be anchored to the head of a femur or other bone in a manner so as to allow compression to be applied to a fracture. The extension extends outward of the bone when attached to the lag screw is anchored to the bone to allow a compression plate to be easily positioned thereof. The cross section of the extension is substantially the same as the cross section of the lag screw to allow the compression plate to be easily and quickly passed onto the lag screw from the extension once the compression plate has been positioned on the extension.

The drawbacks of Richards system, in our opinion, are as follows: a) to mount this system it is necessary to make a great cut in the femur muscular tissues to position a compression plate; b) the bone tissue of the femur head is drilled out over the whole duct length whereby bone tissue (trabeculae) and endosteum are essentially destructed, the blood supply

which is already insufficient is affected; c) the design of the introduced rod and its inadequately effective thread do not provide a stable compression connection of bone parts. At best bone fragments simply come in contact without a stable mutual fixation. Micromobility of bone fragments is as well possible.

Hence a conclusion may be made that Richards system is inefficient for the treatment of femur neck fractures, especially of subcapital fractures which simply do not knit in most cases.

Since the publication of U.S. Pat. No. 4,095,591 and up to now numerous improvements of Richards system have been made in USA and other countries, see U.S. Pat. No. 4,236,512; 4,432,358; 4,791,918; 4,794,919; 4,964,403; 5,871,485 (1978-1999), Patent of Israel No. 54025 (1978).

However all the above mentioned devices have the drawbacks of Richards system- high traumatability of the femur bone and tissues and inadequate efficiency for the treatment of femur neck fractures, such as medial fractures. The application of these devices for the treatment of subcapital fractures is simply unsuitable.

There are also known devices developed by "Howmedica International Inc." (see U.S. Pat. No. 5, 176, 681), "Smith & Nephew Richards Inc." (U.S. Pat. No. 5, 167, 663 and EP 0441577), "Endocare AG" ( U.S. Pat. No. 5, 713, 902). These devices comprise a rod introduced inside the shin bone and a screw attached to this rod to fix the femur neck. The devices are unwieldy, may cause traumas to the patient, and their efficacy is on the level of the Richard system device.

There is further known an "Osteosynthesis device" disclosed in U.S. Pat. No. 5,437,674. An osteosynthesis device including a screw whose tip is pyramidal or conical and whose body is provided, at a distal end thereof, with an outside thread, wherein the head of the screw has a plurality of foldable small wings integral with the body and wherein the screw has a device for folding the small wings. The device is useful particularly for fractures of the scaphoid, of the medial malleolus, Garden fractures 1 and 2 of the neck of the femur, pertrochanterian fractures of the femur, and generally, for fractures of small bones, and for putting in place hip or shoulder stops.

However this device is also inadequately efficient for the treatment of femur neck fractures, such as medial fractures. It cannot be used for the treatment of subcapital fractures.

Closest to the claimed invention is the "Osteosynthesis device for femur neck fractures", USSR Pat. No. 938969. The device comprises a rod with a buttress thread on one end and a hold-down nut on the other end of the rod having an internal thread. There are also provided tabs located in apertures formed in the rod on the side of the hold-down nut and a mechanism for operating the tabs. The mechanism includes a screw disposed in the inner tread of the rod and engaging the tabs.

However this device also has some drawbacks. It is not universal as its design does not allow for the differences in linear femur neck dimensions with different people, different cortical layer thickness in the undertrochanter femur area, does not provide mobility of the antimigration device, and its anchoring in the bone is not secure enough. Therefore such a device must be manufactured individually for each patient or in series differing in dimensions according to anthropological parameters of different patients.

An object of the present invention is to provide a universal and simple device for compression treatment of all kinds of femur neck fractures including medial fractures, such as subcapital fracture which could be

adapted to any anthropological parameters of different patients, easily positioned and, if necessary, easily removed.

Another object of the present invention is to reduce traumatization of a patient's bones and tissues, the time of operation for osteosynthesis at femur neck fractures.

The third object of the present invention is to increase the reliability of anchoring the device in the bone and provide reliable holding together in compression the parts of a fractured femur neck.

## SUMMARY OF THE INVENTION

According to the present invention there is proposed an osteosynthesis device for holding together in compression the parts of a fractured femur neck comprising: a) a screw formed as a step-shaped rod, b) a means to impart rotary motion to the screw, c) an antimigration device for anchoring the screw inside the bone, d) a hold-down nut, e) at least one extension sleeve, f) at least one additional nut.

The step-shaped rod has a longitudinal axis, a through axial hole, a proximal end with a buttress self-tapping thread and a butt shaped as a truncated cone. There is also a distal end with external thread and an internal axial cavity which is provided with internal thread on its distal end and is

associated with the external cylindrical surface of the rod via several longitudinal apertures evenly arranged on this surface and parallel to the generatrix of this surface. The outer diameter of the rod distal end matches the outer diameter of the buttress self-tapping thread on its proximal end.

There is a means to impart rotary motion to the screw, which is disposed on the distal end of the screw and is shaped as a lateral groove.

The antimigration device for anchoring the screw inside the bone is located in the internal axial cavity and comprises a collet chuck with release tabs disposed in the apertures. The collet chuck also has a threaded axial hole.

There is also a mechanism for reciprocal movement of the collet chuck inside the axial cavity and a mechanism for release tabs operation.

The osteosynthesis device includes a hold-down nut located on the rod distal end and movable along its external thread, the nut having a rounded proximal butt and means for registration with a special wrench on the distal butt of the nut.

There is at least one extension sleeve with a through axial hole, a means for connection with the rod distal end and with the external thread. At least one additional nut is located on the external thread of the extension

sleeve and has a rounded proximal butt and means on its distal butt to register with a special wrench.

The claimed osteosynthesis device has a proximal end provided with external buttress self-tapping thread of triangular or trapezoidal cross section, and a front and a rear spiral surface in direction of the rod proximal end. The thread inner diameter and outer diameter are related as 2 : 3. The front surface of the thread is inclined at angles from 30 to 35 degrees. The rear spiral surface of the thread is inclined at angles from 2 to 4 degrees.

The screw proximal end is provided with external buttress self-tapping thread the ends whereof comprise a screw tap, and in the middle of the threaded area and in the body of the screw proximal end there are slots to receive bone chips produced at setting the screw.

The mechanism for reciprocal movement of the collet chuck inside the axial cavity comprises a threaded axial stud reciprocable in the threaded axial hole of this collet chuck, the stud having a lateral slot on its distal end.

The mechanism for release tabs operation comprises a release screw having a conical proximal end and a distal end with a lateral slot. This release screw is placed in the internal thread of the axial cavity to reciprocate and engage with release tabs of the collet chuck.

The osteosynthesis device has at least one extension sleeve with a through axial hole and external thread serving also as a means for connection with the rod distal end by engaging the internal thread of its internal axial cavity, the sleeve being provided with a lateral slot on its free end.

The osteosynthesis device includes a screw formed as a step-shaped rod and an additional strap applied to hold together bone parts solely in lateral femur neck fractures and mounted on the femur outer surface close to the undertrochanter area of the shin bone, the strap being provided with means for its rigid connection with the screw distal end.

The osteosynthesis device additionally comprises a set of adjusting tools including: i) a first spiral drill for the bone; ii) a second spiral drill for the bone; iii) a third spiral drill; iv) a screw holder for femur neck osteosynthesis; v) a special wrench for adjusting the screw for femur neck osteosynthesis together with the antimigration device; vi) a special wrench for adjusting the hold-down and additional nut of the screw for femur neck osteosynthesis; vii) an all-purpose wrench for femur neck osteosynthesis.

The first spiral drill for the bone has a central axis and a through longitudinal axial hole to receive a needle, and an outer diameter no less

than the inner diameter of the buttress self-tapping thread of the screw and the cutting spiral length no less than the maximum femur neck length.

The second spiral drill for the bone has a central axis and a through longitudinal axial hole to receive a needle and an outer diameter greater than the inner diameter of the buttress self-tapping thread by drilling tolerance in bone material and the cutting spiral length no less than the maximum femur neck length.

The third spiral drill for the bone has an outer diameter greater than the outer diameter of the screw distal end, and the cutting spiral length no less than the length of the screw cylindrical surface.

The screw holder for femur neck osteosynthesis comprises a body with a handle on one end and an axial threaded hole on the other end, and the thread of the holder corresponds to the thread on the screw distal end.

There is a special wrench to adjust the screw for femur neck osteosynthesis together with the antimigration device. The wrench includes a body with a handle on one end and an axial threaded hole on the other end. The body external surface around the axial hole is provided by external thread, in the body walls in this area a through lateral slot is formed inside whereof a reciprocable spring-loaded strap is located. The strap ends extend

from the slot and are operatively connected with a special nut disposed on the body external thread and movable along this thread.

There is also a special wrench for adjusting the hold-down and additional nuts. It comprises a body with a handle on one end and an axial hole on the other end, means for registration with the distal butt of a corresponding hold-down or additional nut being provided on the body butt near the axial hole.

There is further an all-purpose wrench comprising a body with a detachable handle in the middle thereof. On one end of the body there is a means to impart rotary motion to the screw or extension sleeve. It includes a step-shaped splined pin with means for matching slots on the butts of this screw or extension sleeve. On the body other end there are provided an axial hole and means for matching with an additional element of the all-purpose wrench. The additional element has planes for matching the above-mentioned body end of the all-purpose wrench and is adapted to engage the lateral slots on the distal end of the threaded stud and release screw.

## BRIEF DESCRIPTION OF THE DRAWINGS

The description of the present invention is accompanied by drawings wherein:

FIG. 1 shows the location of the most frequent femur neck fractures.

FIG. 2 shows an embodiment of the claimed osteosynthesis device with an additional strap.

FIG. 3 shows an additional sleeve and an additional nut.

FIG. 4 shows the most preferable embodiment of the claimed osteosynthesis device (longitudinal section).

FIG. 5 shows a section of the buttress self-tapping thread.

FIG. 6 shows an additional sleeve embodiment.

FIG. 7 shows the first spiral drill.

FIG. 8 shows the second spiral drill.

FIG. 9 shows the third spiral drill.

FIG. 10, 11 show the screw holder.

FIG. 12 – 14 show a special wrench to adjust the screw together with the antimigration device.

FIG. 15, 16 show a special wrench to adjust the hold-down and additional nuts.

FIG. 17, 18 show an all-purpose wrench.

FIG. 19-22 show the sequence of a femur neck osteosynthesis using the claimed device.

## DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

According to the present invention there is proposed an osteosynthesis device for holding together in compression the parts of a fractured femur neck. This device (see FIG.2) includes: a) a screw **100** formed as a step-shaped rod, b) a slot **102** to impart rotary motion to the screw, c) an antimigration device **104** for anchoring screw **100** inside the bone, d) a hold-down nut **106**. Besides there are (see FIG. 3): e) at least one extension sleeve **108**, and f) at least one additional nut **110**.

In another embodiment the osteosynthesis device includes a screw **100** (see FIG. 2) and an additional strap **113** applied to hold together in compression bone parts **solely in lateral femur neck fractures** and mounted on the femur outer surface close to undertrochanter area **16** of the shin bone, strap **113** being rigidly connected with screw **100** distal end.

In the most preferable embodiment of the osteosynthesis device (see FIG. 4) step-shaped rod **112** has a longitudinal axis **114**, a through axial hole **116**, a proximal end **118** with a buttress self-tapping thread **120** and a butt

122 shaped as a truncated cone. There is also a distal end 124 with external thread 126 and an internal axial cavity 128 which is provided with internal thread 130 on its distal end 132 and is associated with external cylindrical surface 134 of rod 112 via several longitudinal apertures 136 evenly arranged on this surface 134 and parallel to the generatrix of this surface. The outer diameter of rod distal end 124 matches the outer diameter of buttress self-tapping thread 120 on its proximal end 118.

External buttress self-tapping thread 120 (see FIG. 4) has, on proximal end 118 of rod 112, ends 138 and 140 comprising a screw tap, and in the middle of the threaded area and in the body of rod 112 proximal end 118 there are grooves 142 to receive bone chips.

External buttress self-tapping thread 120 (see FIG. 5) of triangular or trapezoidal cross section has a front 158 and rear 160 spiral surface in direction of rod 112 proximal end 118. The thread inner diameter and outer diameter are related approximately as 2 : 3. Front spiral surface 158 of thread 120 has a tilt angle $\alpha$ from 30 to 35 degrees. The rear spiral surface 160 of thread 120 has a tilt angle $\beta$ from 2 to 4 degrees.

Antimigration device 150 for anchoring screw 100 inside the bone (see FIG. 4) is located in internal axial cavity 128 and comprises a collet

chuck **152** with release tabs **154** disposed in apertures **136**. The collet chuck **152** also has a threaded axial hole **156** along its axis.

The osteosynthesis device also includes a hold-down nut **162** located on rod **112** distal end **124** and movable along its external thread **126**, nut **162** having a rounded proximal butt **164** and recesses **166** for registration with a special wrench on the distal butt of the nut (see FIG. 6).

Extension sleeve **168** (see FIG. 6) has a step-shaped form, through axial hole **170**, external thread **172** to engage distal end **124** of rod **112**, and external thread **174** which is similar to external thread **126** of rod **112**, sleeve **168** being provided with a lateral groove **169** on its free end. Extension sleeve **168** may have a different design (see FIG. 4) wherein outer thread **172** extends over the whole external surface of this sleeve **168**. At least one additional nut **176** is located on outer thread **172** of extension sleeve **168** and has a rounded proximal butt **178** and recesses **180** on its distal butt to match a special wrench (see FIG. 4).

The osteosynthesis device (see FIG. 4) includes a mechanism for axial reciprocal movement of collet chuck **152** inside axial cavity **128** and a mechanism for release tabs **154** operation. The mechanism for axial reciprocal movement of collet chuck **152** inside axial cavity **128** is a

threaded axial stud **182** reciprocable in threaded axial hole **156** of collet chuck **152**, stud **182** being provided with a lateral slot **184** on its distal end. The mechanism for release tabs **154** operation is a release screw **186** having a cone **188** on the proximal end and a lateral slot **190** on the distal end. This release screw **186** is positioned in internal thread **130** of internal axial cavity **128** to reciprocate and engage release tabs **154** of collet chuck **152**.

The osteosynthesis device additionally comprises a set of adjusting tools including: i) a first spiral drill for the bone; ii) a second spiral drill for the bone; iii) a third spiral drili; iv) a screw hoider for femur neck osteosynthesis; v) a special wrench for adjusting the screw for femur neck osteosynthesis together with the antimigration device; vi) a special wrench for adjusting the hold-down and additional nut of the screw for femur neck osteosynthesis; vii) an all-purpose wrench for femur neck osteosynthesis.

The first spiral drill **200** for the bone (see FIG. 7) has a central axis **202** and a through longitudinal axial hole **204** to receive a needle, and an outer diameter no less than the inner diameter of buttress self-tapping thread **120** of screw **100** and cutting spiral **206** length no less than the maximum femur neck length.

The second spiral drill **210** for the bone (see FIG. 8) has a central axis **212** and a through longitudinal axial hole **214** to receive a needle and an outer diameter greater than the inner diameter of buttress self-tapping thread **120** by drilling tolerance in bone material and cutting spiral **216** length no less than the maximum femur neck length.

The third spiral drill **220** for the bone (see FIG. 9) has an outer diameter greater than the outer diameter of screw **100** distal end, and cutting spiral **222** length no less than the length of rod **112** cylindrical surface **134**.

Screw **100** holder **230** for femur neck osteosynthesis (see FIG. 10) comprises a body **232** with a handle **234** on one end and an axial threaded hole **236** on the other end and the thread of the holder corresponds to external thread **126** on screw **100** distal end **124**. Body **232** of holder **230** has a through axial hole **238** (see FIG. 11).

There is a special wrench **240** to adjust screw **100** for femur neck osteosynthesis together with antimigration device **150** (see FIG. 12). Wrench **240** includes a body **242** with a handle **244** on one end and an axial threaded hole **246** on the other end. External surface **248** of body **242** around axial threaded hole **246** is provided with external thread **250** (see FIG. 13), in body **242** walls in this area a through lateral groove **252** is formed inside whereof a reciprocable spring-loaded strap **254** (see FIG. 14) is located.

Strap **254** ends extend from groove **252** and are operatively connected with a special nut **256** disposed on body **242** external thread **250** and movable along this thread **250**. Strap **254** is loaded by pusher **258** with spring **260** (see FIG. 13, 14).

There is also a special wrench **280** for adjusting hold-down **162** and additional **176** nuts (see FIG. 15, 16). It comprises a body **282** with a handle **284** on one end and an axial hole **286** on the other end, pins **288** being provided on butt of body **282** near axial hole **286** for registration with recesses **166** or **180** on the distal butt of a corresponding hold-down **162** or additional **176** nut.

The set of adjusting tools further includes all-purpose wrench **300** comprising body **302** with a detachable handle **304** in the middle thereof. On one end of body **302** there is a means to impart rotary motion to screw **100** or extension sleeve **168**. It includes a step-shaped splined pin **306** with splines **308** for matching lateral grooves **102** or **169** respectively on the butts of this screw **100** or extension sleeve **168**. On the other end of body **302** there are provided an axial hole **310** and projections **312** for matching with an additional element **320**. Additional element **320** has planes **322** for matching with projections **310** and a spline **324** adapted to engage lateral

groove **184** or **190** on the distal end of threaded stud **182** or release screw **186**.

The claimed device is applied as follows.

Fracture fragments are reponed under periodic X-ray observation. A 3-4 cm long cut is made to expose undertrochanter area **16** of the femur bone. In the spot wherein Trochanter major changes to Diafiz **18** a twist drill needle is passed, by means of a drill, in direction of the femur neck axis. The bone cortical layer **17**, 2 cm thick, is removed by a chisel around the needle end. Then, under periodic X-ray control, a hole is drilled out using in succession first spiral drill **200**, second spiral drill **210** and third spiral drill **220** (see FIG. 19). In this case first spiral drill **200** and second spiral drill **210** are set by their longitudinal axial hole, **204** and **214** respectively, onto twist drill needle, and the drill is advanced in direction of the femur neck axis using the twist drill needle as a guide rod. The drilling depth is a little greater than the length of screw **100**. Third spiral drill **220** is advanced by a brace to the depth of this part of the hole which exceeds a little the length of cylindrical external surface **134**, drilling out the hole which remained after the passage of drills **200** and **210**.

Then driving of screw **100** (see FIG. 20) is started. By this moment screw **100** is already set by its external thread **126** in axial threaded hole **236** of holder **230** and fixed in this holder **230** by hold-down nut **162.** Screw **100** is passed through this part of the bone hole which has been drilled out by third drill **220**, and then driven in the remaining part of this hole using end **138** of external buttress self-tapping thread **120** (see FIG. 20) as a screw tap. Bone chips generated in the process fill grooves **142** in the middle of the threaded portion and in the body of proximal end **118** of rod **112.** At this stage it is possible to use a twist drill needle as a guide rod to set screw **100** more precisely. To this end the twist drill needle is passed in through axial hole **116** of screw **100** and in through axial hole **238** in body **232** of holder **230** (see FIG. 20). Once screw **100** has been driven, holder **230** is separated from screw **100**, and inside axial cavity **128** of screw **100** there is mounted antimigration device **150.** Such a procedure of setting screw **100** is used when the severity of bone osteoporosis is very high.

The most preferable variant is to set screw **100** together with antimigration device **150** (see FIG. 21). For this purpose a special wrench **240** is used. Screw **100** is previously inserted by its external thread **126** in axial threaded hole 246 of a special wrench **240** and fixed in this wrench **240** by hold-down nut **162.** Therewith strap **254** is moved along groove **252**

by a special nut **256,** introduced into groove **102** on the distal end of screw **100** and fixed in this position in groove **102.** Thereafter driving of screw **100** (see FIG. 21) is started by turning handle **244** of special wrench **240.** This is carried out in the same way as by holder **230.** Once screw **100** has been driven, special wrench **240** is separated therefrom. To facilitate unscrewing a special nut **256** is slightly turned in direction of the proximal end of screw **100,** strap **254** being slightly advanced along groove **252** and acting axially on groove **102** of screw **100.**

Once screw **100** has been mounted, femur head **12** and neck **13** are made coincident and held down in compression. To this end special wrench **280** is put over hold-down nut **162,** by matching pins **288** of wrench **280** with recesses **166** on butt of hold-down nut **162.** Then, by turning special wrench **280,** nut **162** is held down until it is against the bone cortical surface **17.** The tightening of nut **162** by means of buttress thread **120** causes compression of the bone endosteum. The femur head **12** and neck **13** are made coincident and pressed together tightly.

If the length of screw **100** is inadequate, it can be increased by using one or several extension sleeves **168** (see FIG. 6). Sleeve **168** is partly screwed in along thread **130** into internal axial cavity **128** of screw **100** by means of all-purpose wrench **300.** In this case, to hold together femur head

12 and neck **13**, instead of hold-down nut **162**, additional nut **176** is used. Nut **176** is screwed up by means of the same special wrench **280**.

On making the bone parts coincident in compression, antimigration device **150** (see FIG. 22) is positioned in the desired place and fixed. To position antimigration device **150** in the desired place threaded axial stud **182** is turned by means of additional element **320** of all-purpose wrench **300**. Therewith collet chuck **152** of antimigration device **150** advances along internal axial cavity **128** (under periodic X-ray control) until the ends of its release tabs **154** come into the necessary position inside the bone, near cortical layer **17**. Then release tabs **154** are drawn aside and extended from apertures **136** by means of release screw **186** moved along thread **130** by means of additional element **320** of all-purpose wrench **300**. Thereby antimigration device **150** is fixed in the desired position and a paddle system is formed to hold screw **100** inside the bone and exclude mobility and rotation of bone fragments.

**Solely in treating lateral fractures** of femur neck it is possible to apply strap **113**, which is placed on the femur external surface near undertrochanter area **16** (see FIG. 2). In this case strap **113** is rigidly connected with the distal end of screw **100**.

If necessary, screw **100** may be removed after the union of femur neck parts. For this purpose the above procedure is carried out in the reverse order. First release screw **186** is removed, then, by turning axial threaded stud **182,** collet chuck **152** of antimigration device **150** is moved inside axial cavity **128,** opening thereby its release tabs **154** and retracting them into apertures **136.** This is carried out by means of additional element **320** of all-purpose wrench **300**. Thereafter, by means of special wrench **280**, hold-down nut **162** is unscrewed (and strap **113** is removed if it has been mounted). Then special wrench **240** or holder **230** is screwed on thread **126** and fixed in this position. Thereupon screw **100** is removed from the femur neck. To facilitate the removal of screw **100**, end **140** of its self-tapping buttress thread **120** is formed as a screw tap. Such a design of thread **120** allows to use its end **140** for cutting off excrescences of bone tissue which have grown in the hole channel in the femur neck wherefrom screw **100** is removed. The removal of screw **100** is performed under periodic X-ray control.

Application of the claimed device for femur neck osteosynthesis provides accurate and secure matching of bone fragments in compression during the whole period of the fracture union. Besides the duration of

surgical interference is essentially reduced and traumatization of endosteum and bone marrow of the femur head and neck is insignificant. The claimed device is suitable for compression treatment of all kinds of femur neck fractures, including medial fractures, such as subcapital fracture. And finally the claimed device is adapted to any anthropological parameters of different patients, easily mounted and, when necessary, easily removed.

Obviously, numerous modifications and variations of the present invention are possible in light of the above teachings. It is therefore to be understood that within the scope of the appended claims, the invention may be practiced otherwise than as specifically described herein.

# CLAIMS

We claim:

1. An osteosynthesis device for holding together in compression the parts of a fractured femur neck comprising:

   a) a screw designed as a step-shaped rod having a through axial hole, a proximal end with self-tapping thread and a butt shaped as a truncated cone, and a distal end with external thread and internal axial cavity which is provided with internal thread on the distal end and is associated with a cylindrical external surface of said rod via several longitudinal apertures evenly arranged on this surface, parallel to the generatrix of said surface, the outer diameter of said rod distal end corresponding to the outer diameter of a buttress self-tapping thread on the proximal end of said rod;

   b) a means to impart rotary motion to the screw disposed on the distal end of said screw;

   c) an antimigration device for anchoring said screw inside the bone located in said internal axial cavity and comprising a collet chuck with release tabs disposed in said apertures, and a mechanism for

reciprocal movement of the collet chuck inside said axial cavity and a mechanism for release tabs operation;

d) a hold-down nut located on said rod distal end and movable axially along its external thread, said nut having a rounded proximal butt and means for registration with a special wrench on the distal butt of the nut.

e) at least one extension sleeve having a through axial hole, a means for connection with the rod distal end and an external thread;

f) at least one additional nut located on the external thread of at least one said extension sleeve and having a rounded proximal butt and means on its distal butt to register with a special wrench.

2. A device according to claim 1, wherein said screw comprises a step-shaped rod, the proximal end whereof is provided with an external buttress self-tapping thread having spiral surfaces, front and rear in direction of said proximal rod end, the internal and external diameter of said thread are related approximately as 2 : 3.

3. A device according to claim 2 wherein said buttress self-tapping thread is of triangular cross section.

4. A device according to claim 2 wherein said buttress self-tapping thread is of trapezoidal cross section.

5. A device according to claim 2 wherein said front spiral surface of said thread is inclined at angles from 30 to 35 degrees.

6. A device according to claim 2 wherein said rear spiral surface of said thread is inclined at angles from 2 to 4 degrees.

7. A device according to claim 2 wherein the distal end of said screw is provided with an external buttress self-tapping thread the ends whereof are shaped as screw tap, and in the middle of the threaded portion and in the body of said screw proximal end there are grooves to receive bone chips produced during said screw positioning.

8. A device according to claim 1 wherein said means to impart rotary motion to the screw disposed on the distal end of said screw is a lateral groove.

9. A device according to claim 1 wherein said antimigration device is located in said internal axial cavity and formed as a collet chuck with

release tabs and a threaded axial hole, a mechanism of axial reciprocal movement of the collet chuck inside said axial cavity and a mechanism for release tabs operation.

10. A device according to claim 9 wherein said mechanism of axial reciprocal movement of said collet chuck inside said axial cavity is a threaded axial stud reciprocable in the threaded axial hole of said collet chuck, the stud being provided with a lateral slot on its distal end.

11. A device according to claim 9 wherein said mechanism of release tabs operation is a release screw having a conical proximal end and a distal end with a lateral slot, said release screw being positioned in the internal thread of said axial cavity to reciprocate and interact with said release tabs of said collet chuck.

12. A device according to claim 1 wherein at least one said extension sleeve has a through axial hole and external thread which also serves as said means for connection with said rod distal end by engaging the internal thread of said internal axial cavity, the sleeve having a lateral slot on its free end.

13. A device according to claim 1 including a screw formed as a step-shaped rod with said antimigration device, said hold-down nut, at least one said extension sleeve and at least one said additional nut, as well as an additional strap applied for holding together in compression bone parts at lateral fractures of the femur neck and mounted on the femur external surface near the undertrochanter area of the shin bone, said strap being provided with means for rigid connection with said screw distal end.

14. An osteosynthesis device for holding together in compression the parts of a fractured femur neck additionally comprising a set of adjusting tools including:

i) a first spiral drill for the bone;

ii) a second spiral drill for the bone;

iii) a third spiral drill;

iv) a screw holder for femur neck osteosynthesis;

v) a special wrench to position said screw for femur neck osteosynthesis together with said antimigration device;

vi) a special wrench to mount said hold-down nut and additional nut of said screw for femur neck osteosynthesis;

vii) an all-purpose wrench for femur neck osteosynthesis.

15. A device according to claim 14 wherein said first spiral drill for the bone has a central axis and a through longitudinal axial hole to receive a needle and an outer diameter no less than the inner diameter of the buttress self-tapping thread of said screw and a cutting spiral length no less than the maximum length of the femur neck.

16. A device according to claim 14 wherein said second spiral drill for the bone has a central axis and a through longitudinal axial hole to receive a needle, as well as an outer diameter greater than the inner diameter of said self-tapping thread by drilling tolerance in bone material and a cutting spiral length no less then the maximum length of said femur neck.

17. A device according to claim 14 wherein said third spiral drill for the bone has an outer diameter greater than the outer diameter of said screw distal end, and a cutting spiral length no less than the length of said screw cylindrical surface.

18. A device according to claim i4 wherein said screw holder for femur neck osteosynthesis comprises a body with a handle on one end and an

axial threaded hole on the other end, the thread of said hole corresponding to said external thread on said screw distal end.

19. A device according to claim 14 wherein said special wrench to position said screw for femur neck osteosynthesis together with said antimigration device includes a body with a handle on one end and an axial threaded hole on the other end, the external surface of the body around said axial hole is provided with external thread, in said body walls in this area there is provided a through lateral groove inside whereof there is located a spring-loaded reciprocable strap the ends whereof extend from the groove and are operatively connected with a special nut located on said body external thread and movable along this thread.

20. A device according to claim 14 wherein said special wrench to position said hold-down nut and said additional nut of said screw for femur neck osteosynthesis comprises a body with a handle on one end and an axial hole on the other end, and on said body butt, near said axial hole, there are means for matching the distal butt of a corresponding hold-down or additional nut.

21. A device according to claim 14 wherein said all-purpose wrench for femur neck osteosynthesis comprises a body with a handle in the middle thereof, and on one end of said body there is said means to impart rotary motion to said screw or extension sleeve, said means comprising a step-shaped splined pin with means for matching lateral grooves on the distal butt of said screw or extension sleeve, and on the other end of said body there are provided an axial hole and means for matching an additional element.

22. A device according to claim 21 wherein said all-purpose wrench for femur neck osteosynthesis is provided with an additional element matching one of its ends and adapted to engage the lateral slots on said distal end of said threaded stud and release screw.

# ABSTRACT

The present invention relates to medicine, and more particularly, to devices applied for osteosynthesis at femur neck fractures. The device comprises a screw formed as a step-shaped rod having a longitudinal axis, a through axial hole, a proximal end with a buttress self-tapping thread and a butt shaped as a truncated cone, as well as a distal end with external thread and an internal axial cavity which is provided with internal thread on its distal end and associated with cylindrical external surface of the rod via several longitudinal apertures evenly arranged over this surface, parallel to the generatrix thereof, the outer diameter of the rod distal end corresponds to the outer diameter of the self-tapping thread on its proximal end. There is an antimigration device to fix the screw inside the bone located in the internal axial cavity and comprising a collet chuck with release tabs disposed in apertures, a mechanism for axial reciprocal movement of the collet chuck inside said axial cavity and a mechanism for release tabs operation. The device further includes a hold-down nut located on the rod distal end, at least one extension sleeve and at least one additional nut disposed on external

thread of said extension sleeve. The osteosynthesis device is additionally provided with a set of adjusting tools which includes drills for the bone, a screw holder and wrenches to adjust the screw, a hold-down and additional nut, as well as the antimigration device elements. The device may be provided with an additional strap for treatment of lateral femur neck fractures.

**22 Claims, 12 Drawing Sheets**

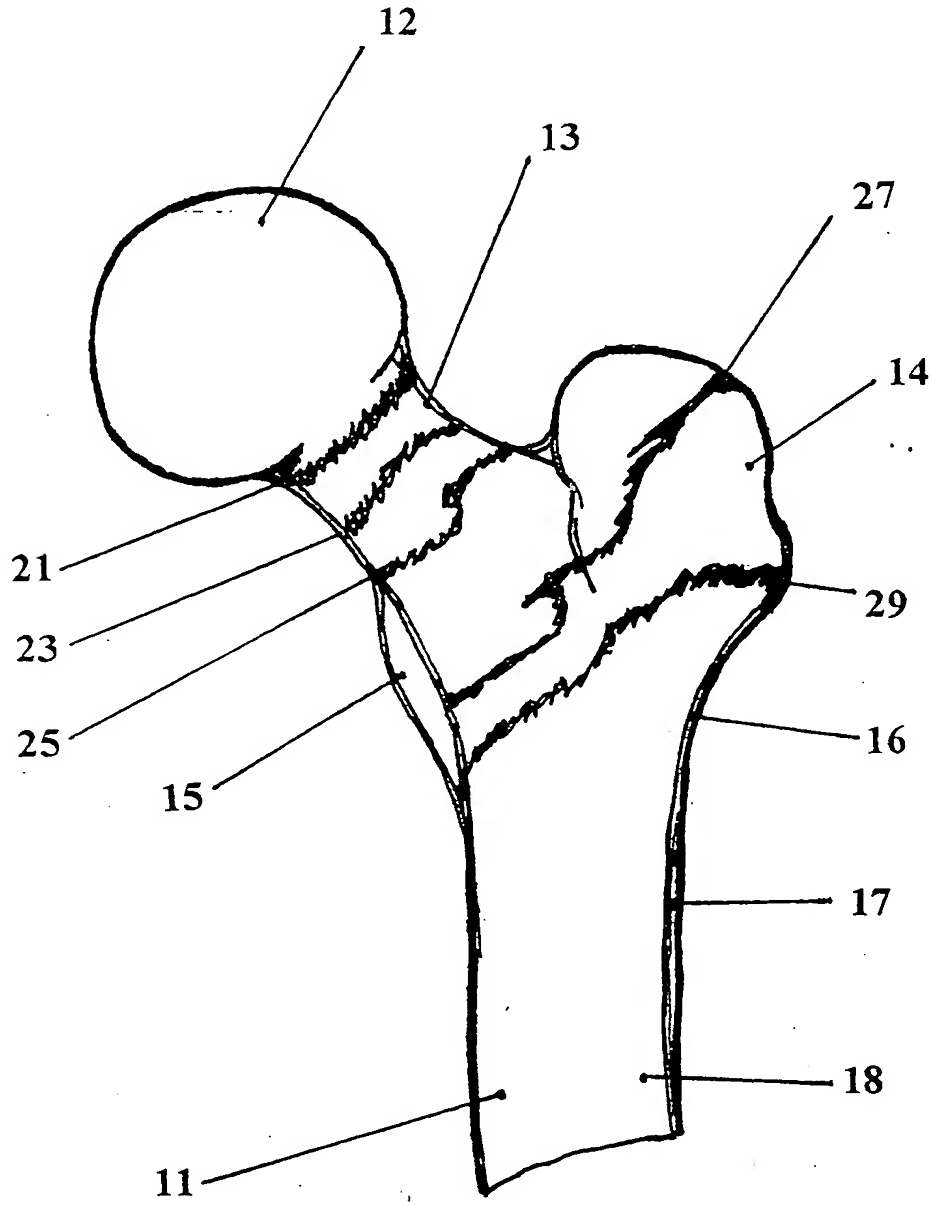


FIG. 1

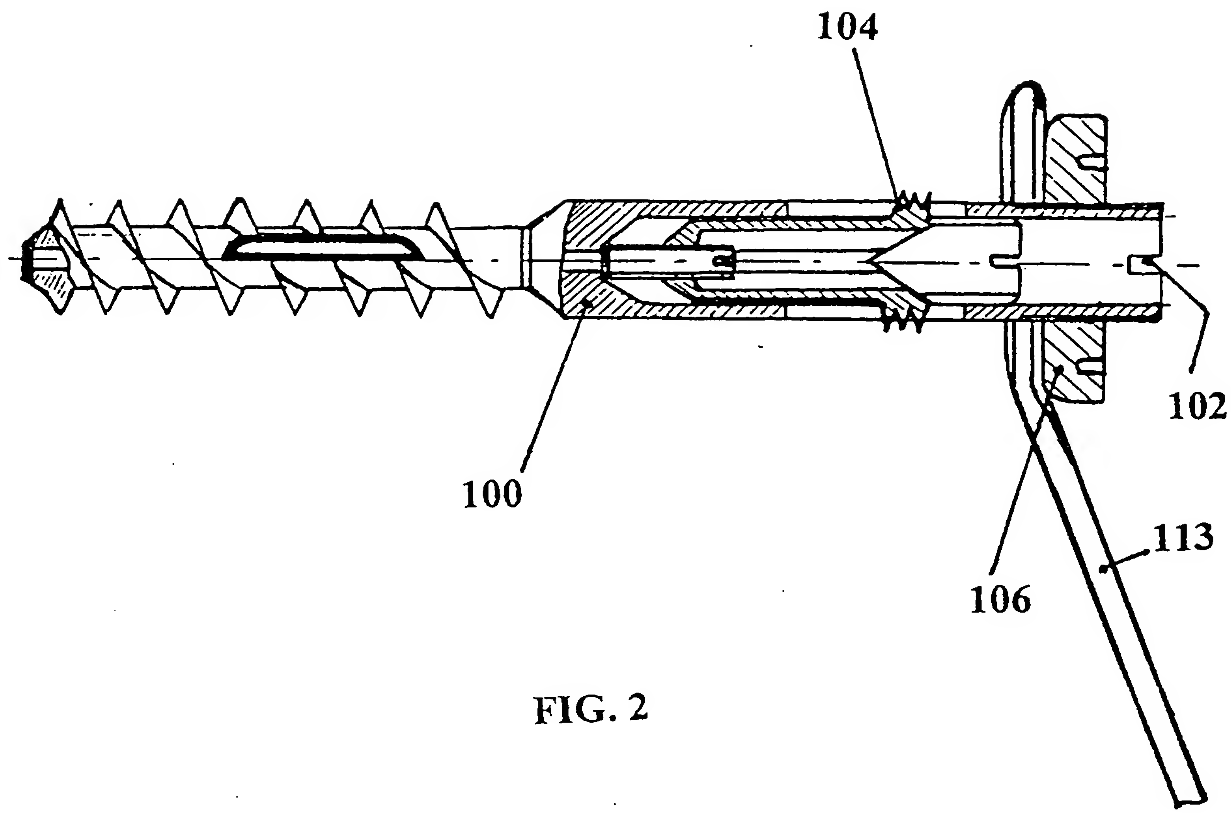


FIG. 2

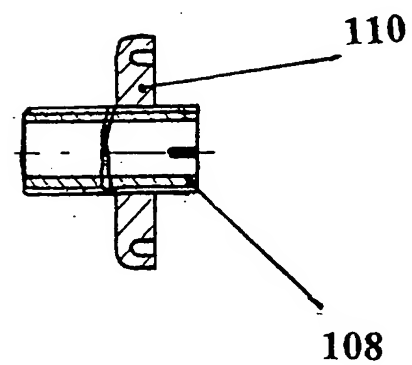


FIG. 3

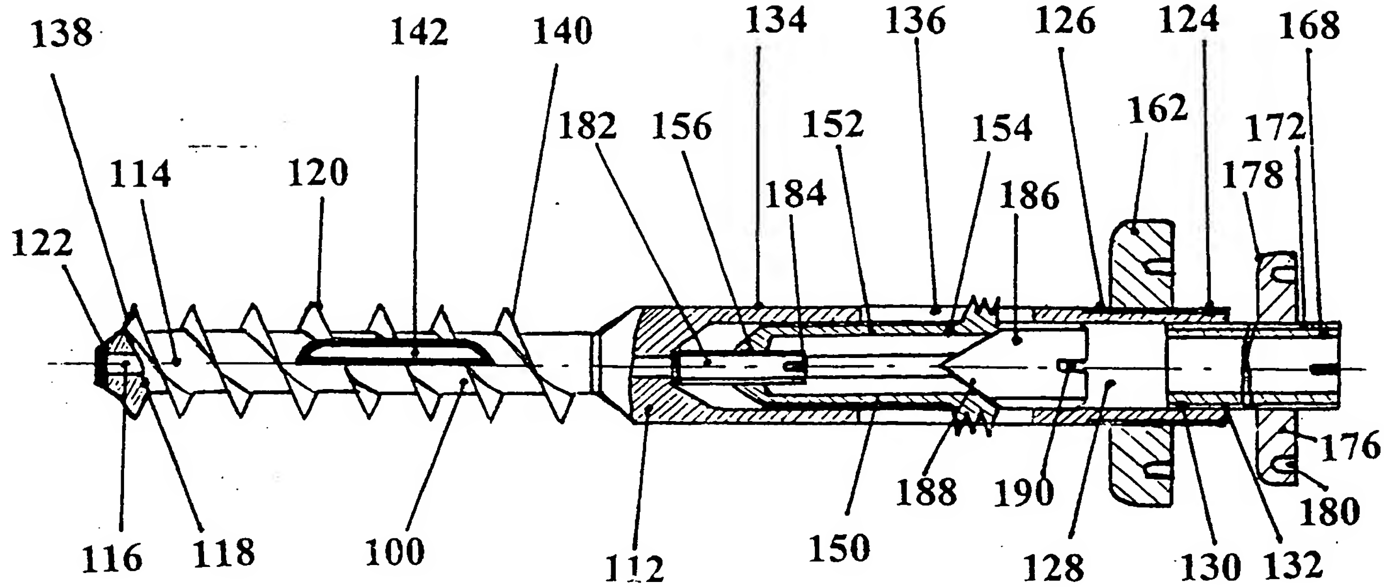


FIG. 4

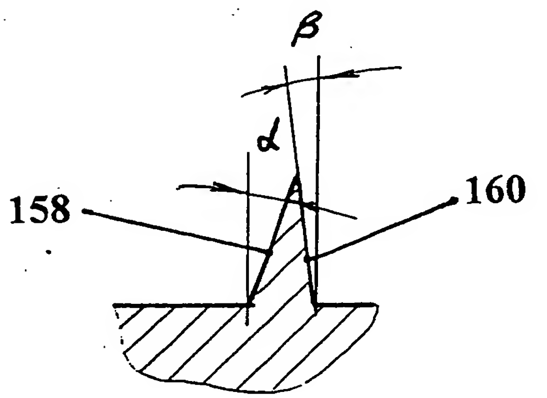


FIG. 5

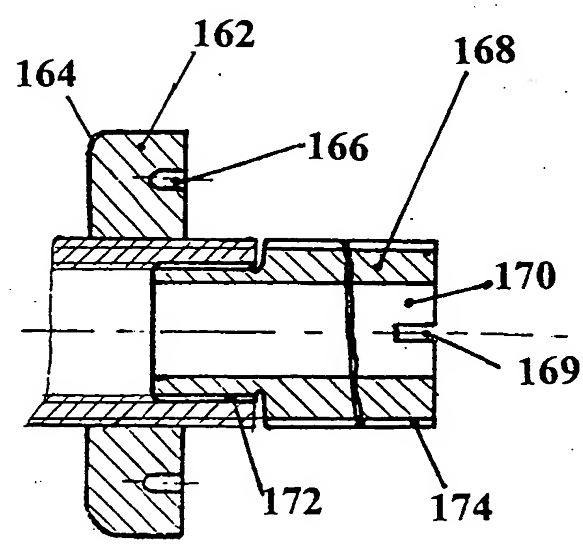


FIG. 6

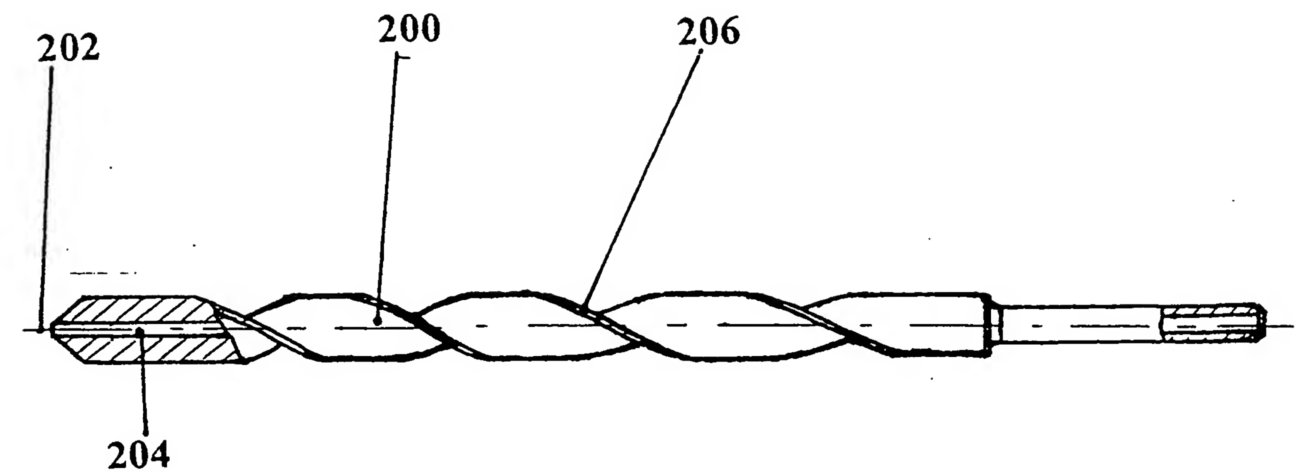


FIG. 7

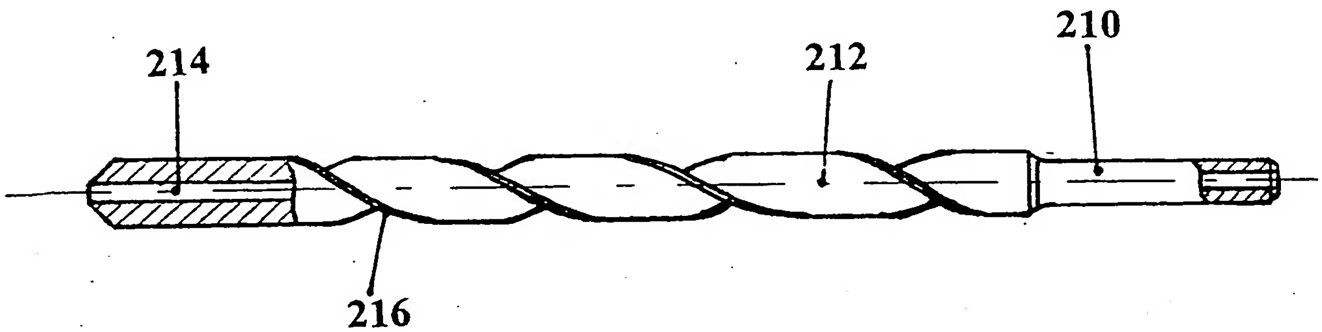


FIG. 8

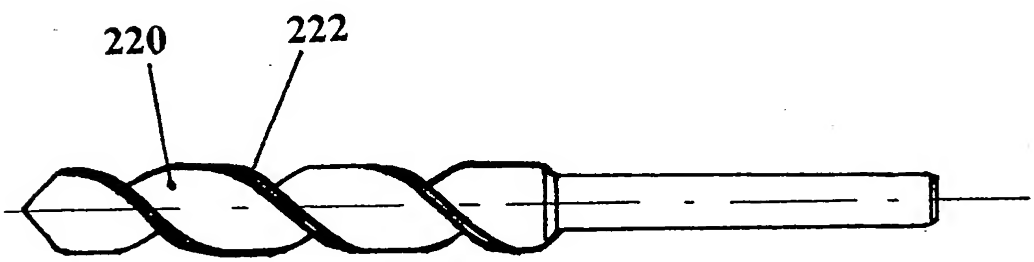


FIG. 9

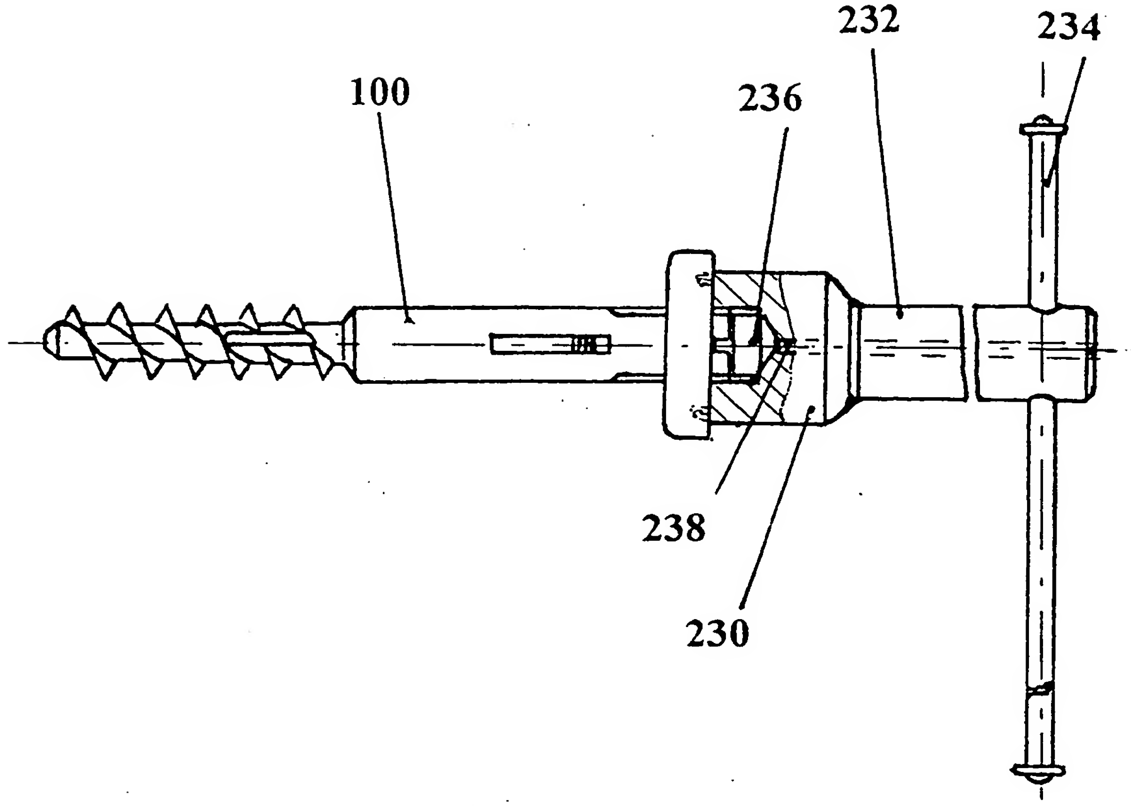


FIG. 10

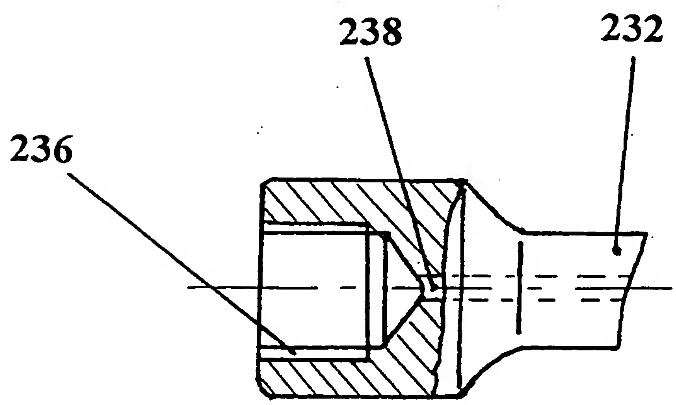


FIG. 11

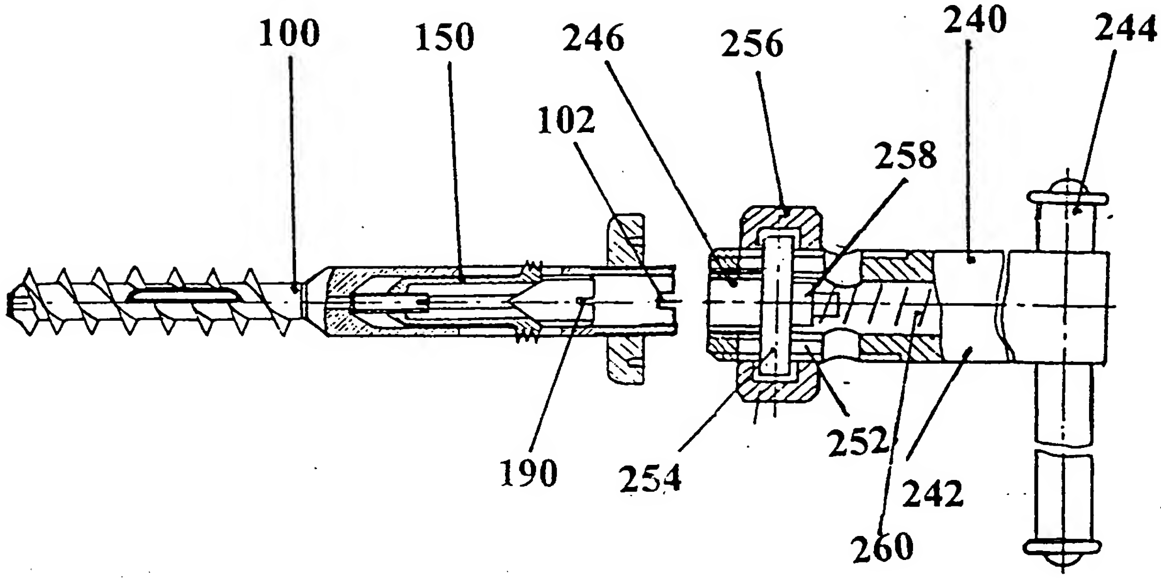


FIG. 12

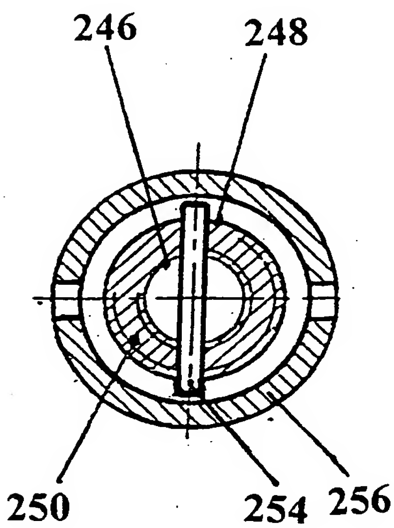


FIG. 13

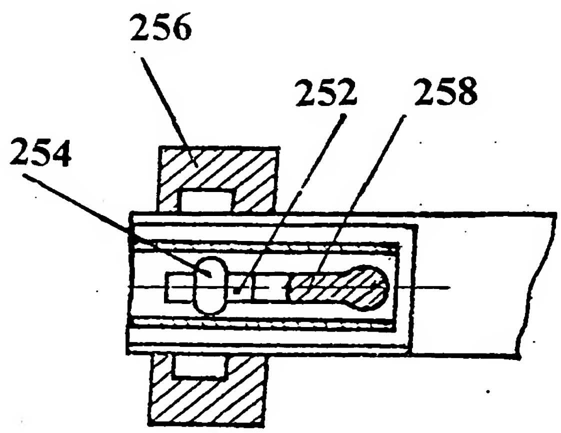


FIG. 14

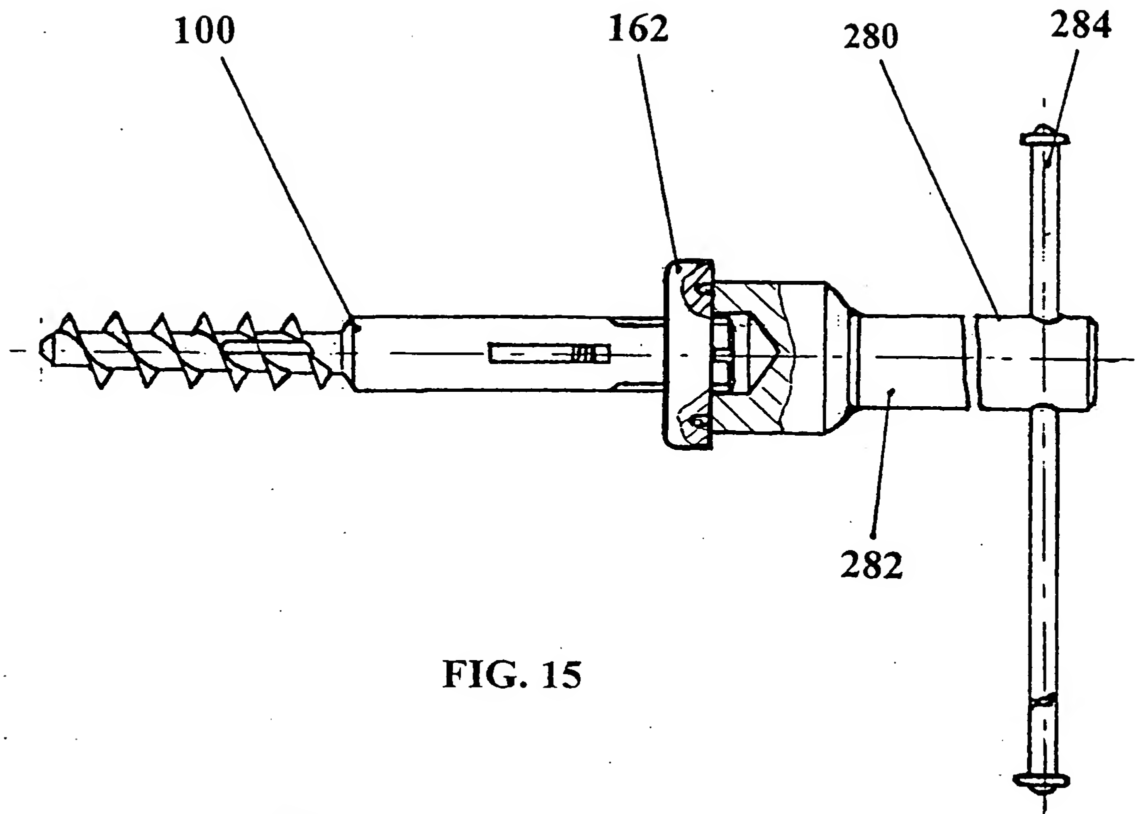


FIG. 15

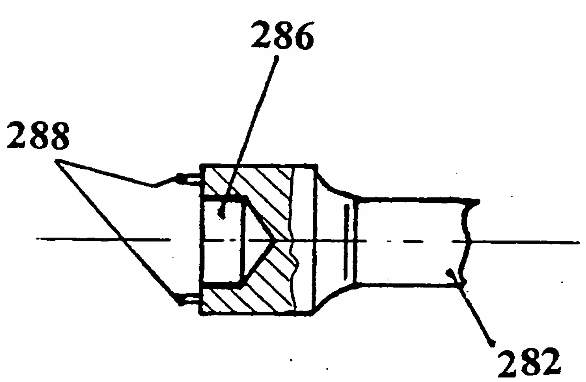


FIG. 16

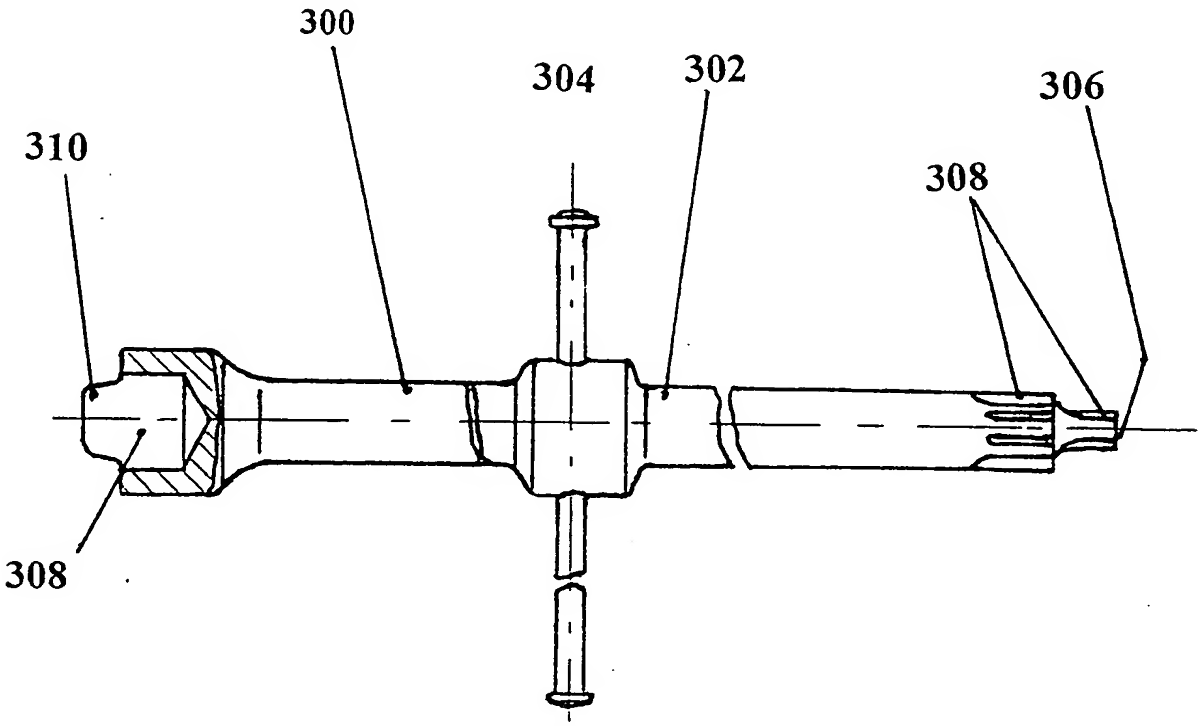


FIG. 17

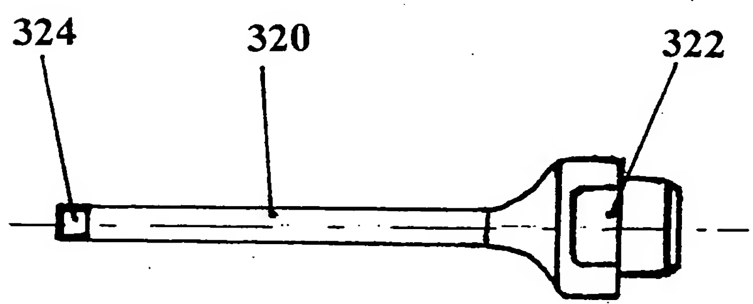


FIG. 18

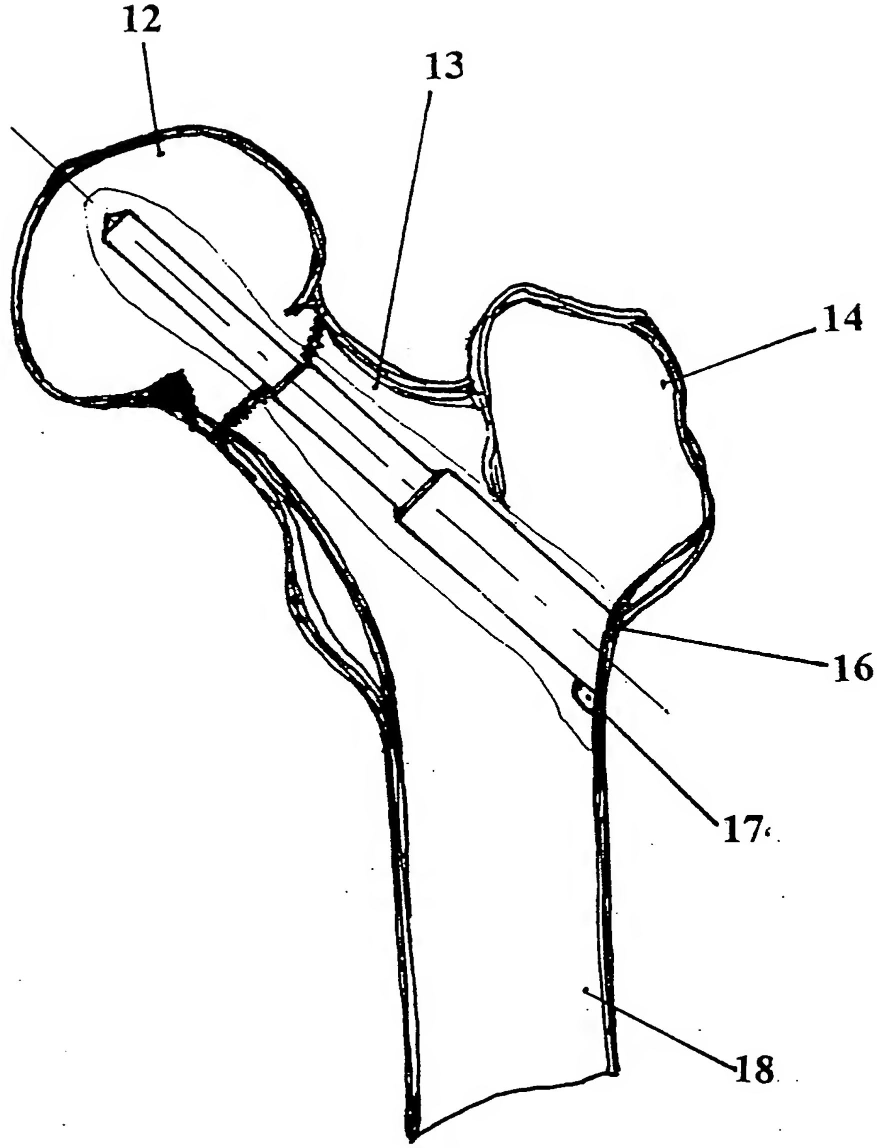


FIG. 19

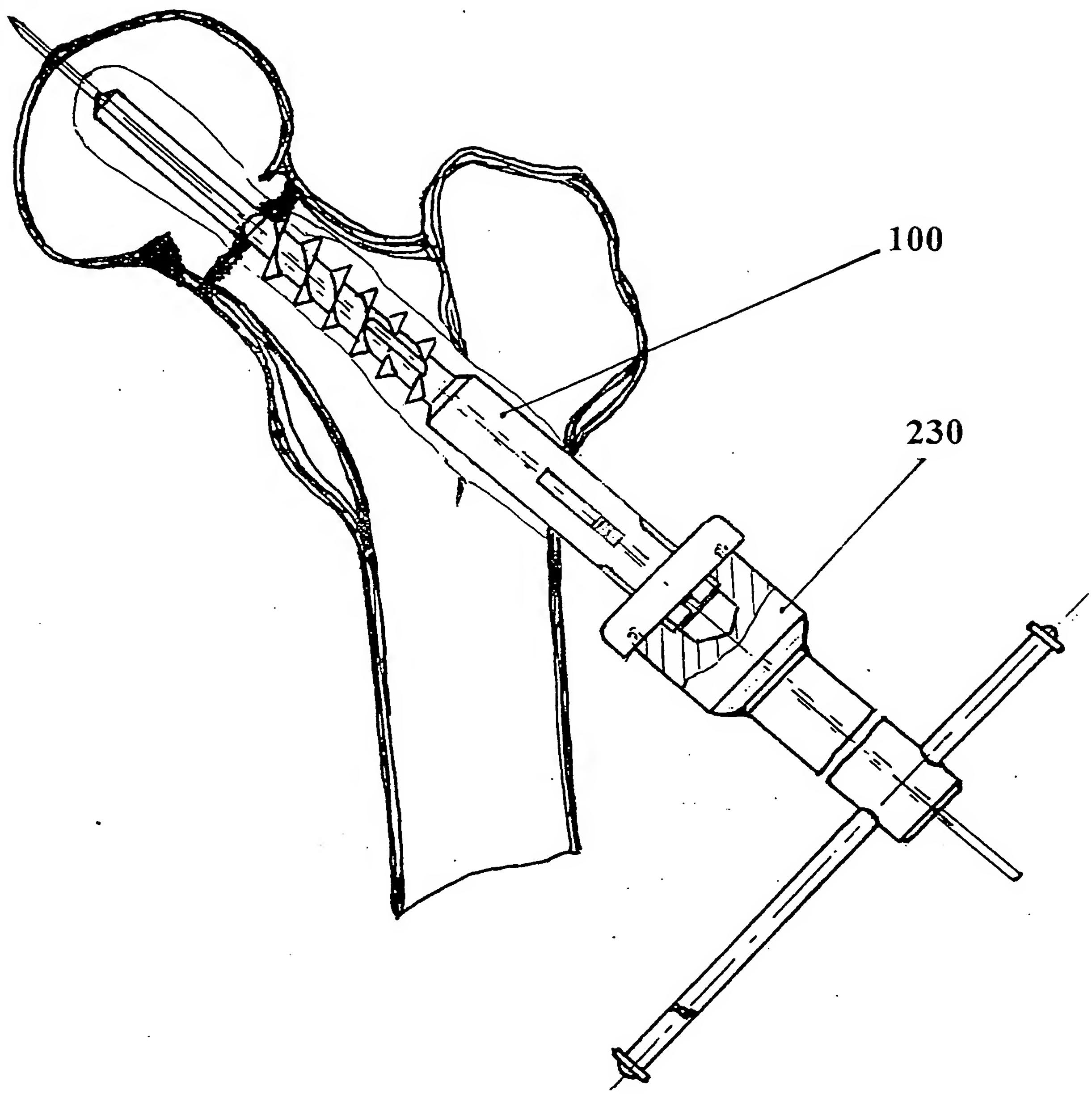


FIG. 20

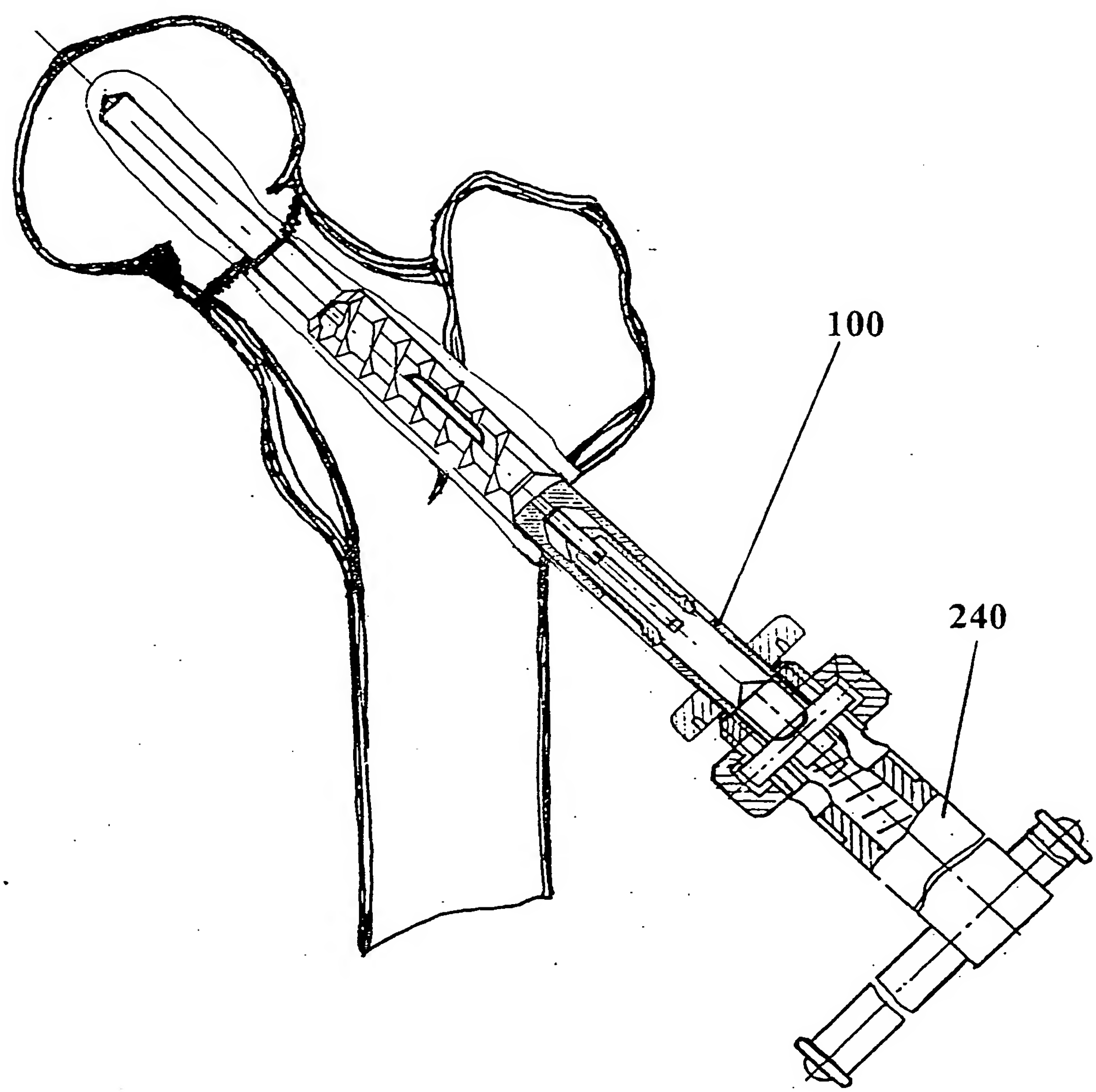


FIG. 21

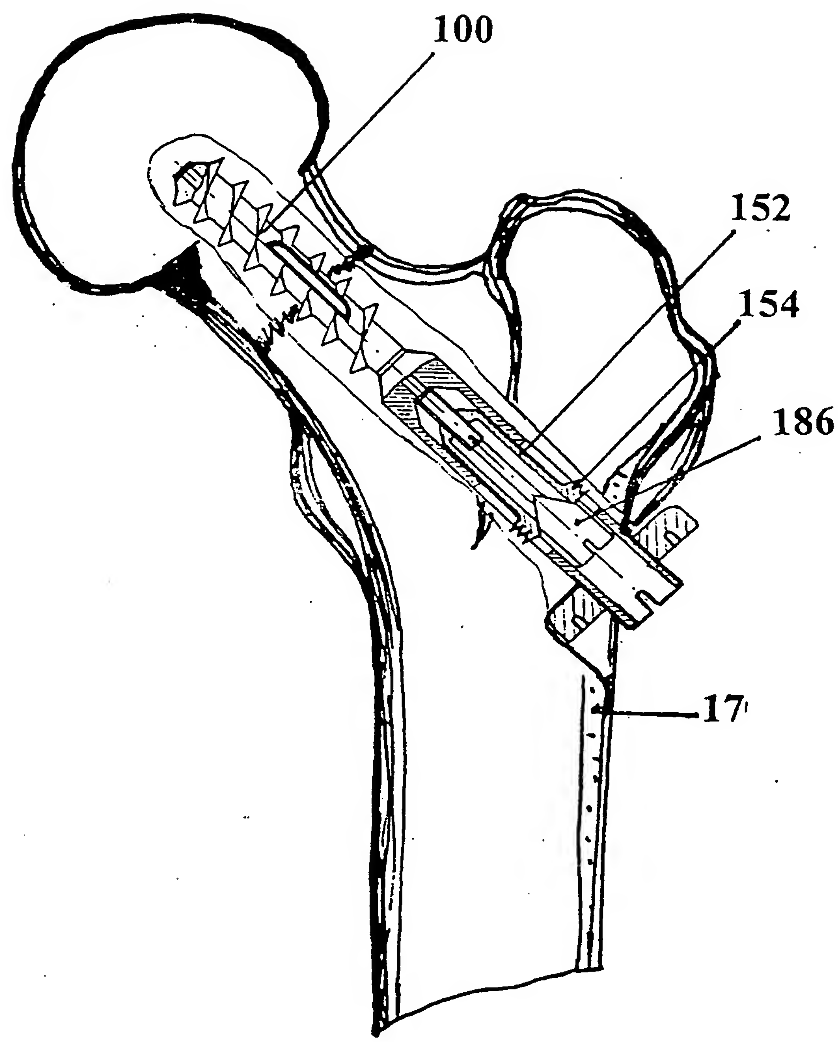


FIG. 22